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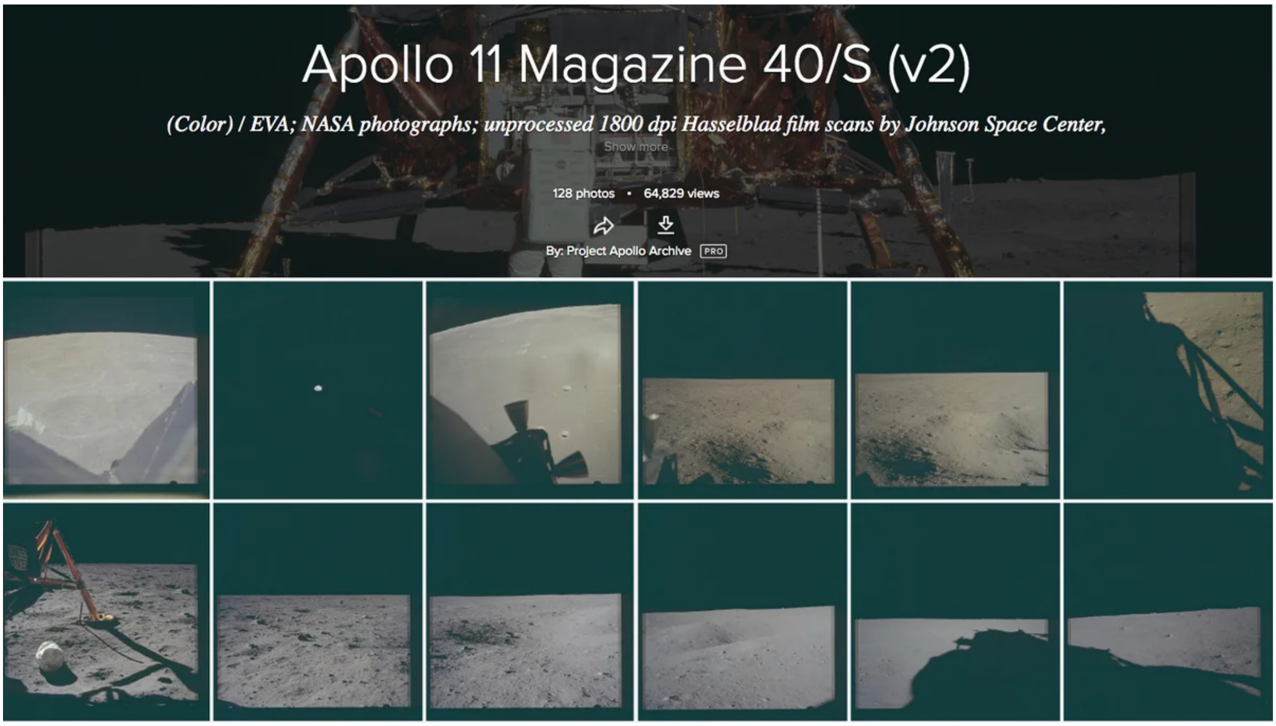
48. Почему чёрный космос на снимках НАСА стал зелёным?

11-13 minutes

In 2005, the lunar images were re-scanned at high resolution (1800 dpi) and posted on the Internet - “for all mankind”. Most of the frames were aligned with a graphic editor for brightness and contrast, but nevertheless, Flicker can find unprocessed scanned originals. And here's the strange thing: in all these frames, the black space turned green.
This is especially striking if there is a black edging nearby.

Black space looks dark green.

And this is not a single shot, this is a rule. This is a trend that at first glance seems inexplicable. Deep black space appears dark green in almost all color images.



Black space looks dark green in almost all frames.

We are very far from the idea that Kodak has supplied defective reversible **Ektahrom** photographic film to NASA for several years.... On the contrary, we are confident that the Kodak film was well balanced in both layer sensitivity and contrast. And even such an option that the processing mode of the photographic film was violated, we also do not consider. We are sure that the processing mode was impeccable, strictly regulated, namely E-6, and that the temperature of the developer was maintained with an accuracy of ± 0.15 ° by automatic temperature control (thermostats), and the chemical composition of the solutions was monitored by experienced chemists. And on this issue - on the issue of film processing - the laboratory did not deviate from the process developed for this type of film. Therefore, we believe that the absence of a dense black tone in the images has nothing to do with the processing of the photographic film.

Especially for those who, during the Soviet Union years at home in the bathroom independently developed color films, and did not have, apart from a thermometer, **not a single way to control solutions** , we will write an article on how a professional film laboratory works, and how the chemical composition is checked every day (!) developer. After all, there will certainly be amateur photographers who will write that the processing process has always given different results that have not been repeated, especially if you develop expired chemicals that have been lying in the barn for 30 years.

When we see that black space in NASA images has turned green, we immediately exclude the processing and quality of Kodak films from the causes of anomalies. The quality of Kodak is beyond competition.

So maybe the color change in the shadows happened during the scanning stage? We see that the blackest areas after scanning have become lighter.

Perhaps the range of densities, from the lightest to the darkest, that the scanner can “illuminate” is much larger than the range of image densities on the slide?

To give an unambiguous answer about the effect of scanning, it is necessary to clarify two questions: what is the range of densities usually on a slide (slides are called images on reversible film) and what is the maximum range of densities that the scanner can “penetrate”?

Slide 6x6 cm.

Since we are talking about a range of densities, we need a device to measure the density. It is called a **densitometer** , from the English word “density” - “density”. A unit (1 Bel) is taken to be such an opacity that reduces the amount of transmitted light by a factor of 10, or, in other words, allows 10% of the light to pass through. Density 2 reduces light by a factor of 100, allowing only 1% of the light to pass through, while density 3 attenuates the luminous flux by a factor of a thousand, and, accordingly, allows only 0.1% of the light to pass through.

D	0,0	0,3	0,6	0,9	1,0	2,0	3,0
Кол-во прошедшего света	100%	50%	25%	12,5%	10%	1%	0,1%

The relationship between density and the amount of transmitted light.

It is quite easy to visualize the unit of density. So, sunglasses with polarizing filters most often have a density of about unity. The glasses that we had at our disposal had a density D = 1.01, i.e. weakened the light just 10 times.

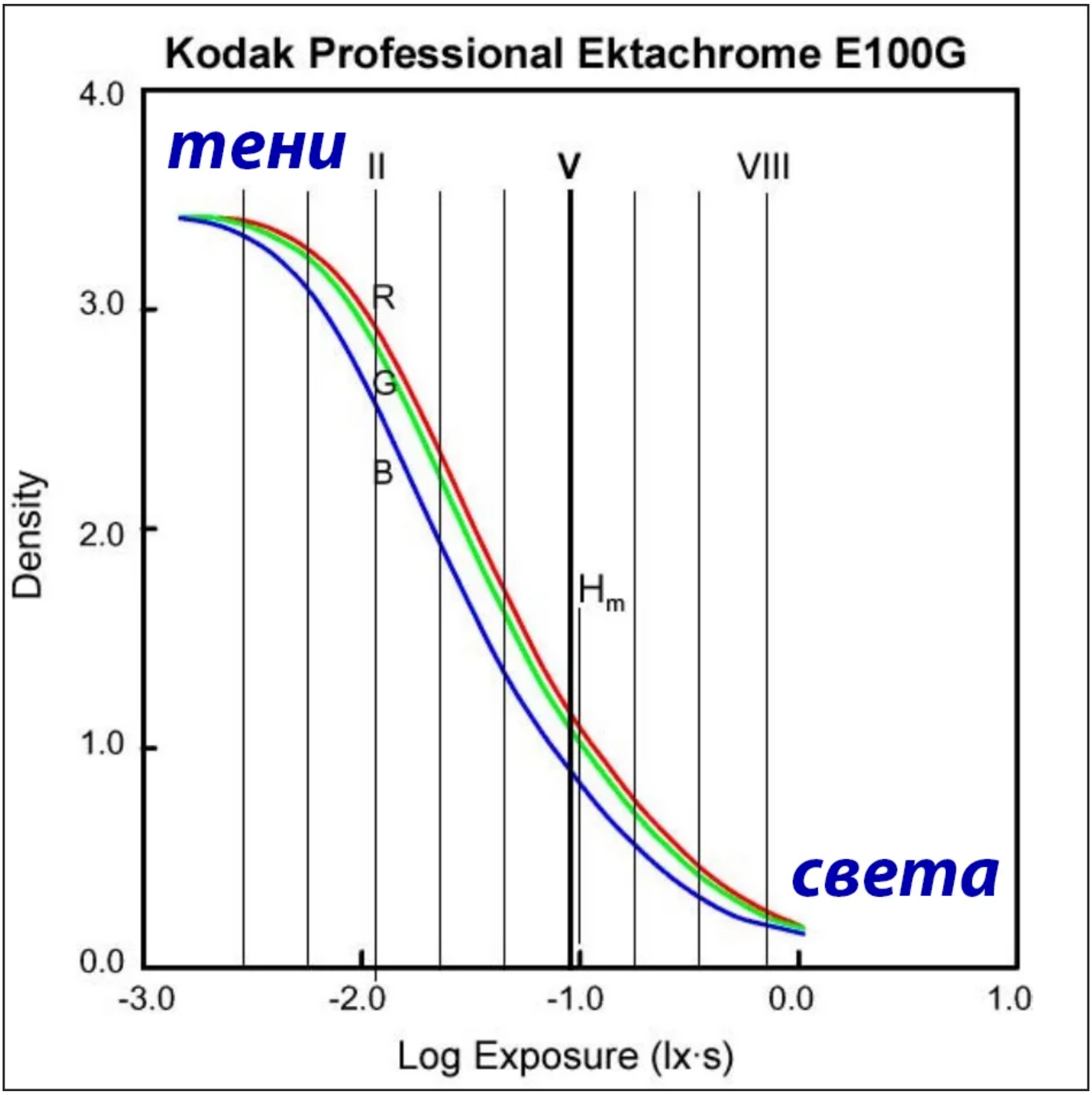
Measurement of the density of sunglasses on a Macbeth TD-504 densitometer.

The interframe space, the darkest area on the color positive film, had a density of more than 3 B (D = 3.04), which meant that the light was weakened by a factor of 1000.

The darkest place in a film print is the space between frames.

Measurement of the darkest area on a 70 mm film print

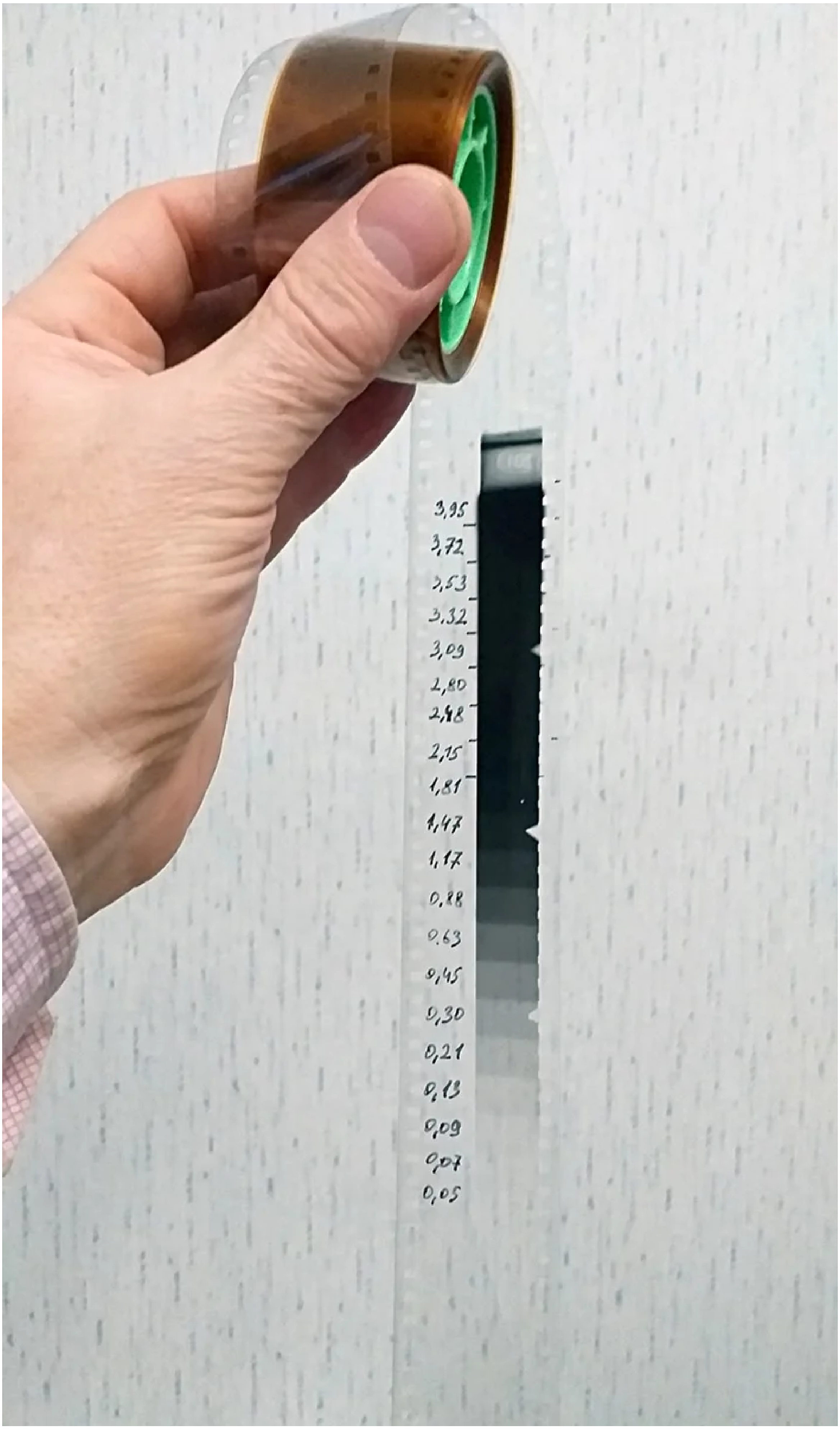
On the Internet you can find characteristic curves of reversible Ektachrom photographic film. The curve shows how the film reacts to different amounts of light. The amount of light is the exposure and is plotted on a horizontal scale as a logarithmic value (expressed in lux seconds). The vertical scale is the density response of the film. The maximum density that is achieved on this film in dark areas (these areas are called **shadows**) is 3.4 B.



Characteristic curves of Ektachrom reversible color film. The maximum shadow density is 3.4 B.

We measured the darkest spots on our available Kodak Ektahrom film slides. The maximum densities are from 2.6 to 3.1 B. As follows from the characteristic curves, a density of 3.4 B can ideally be achieved.

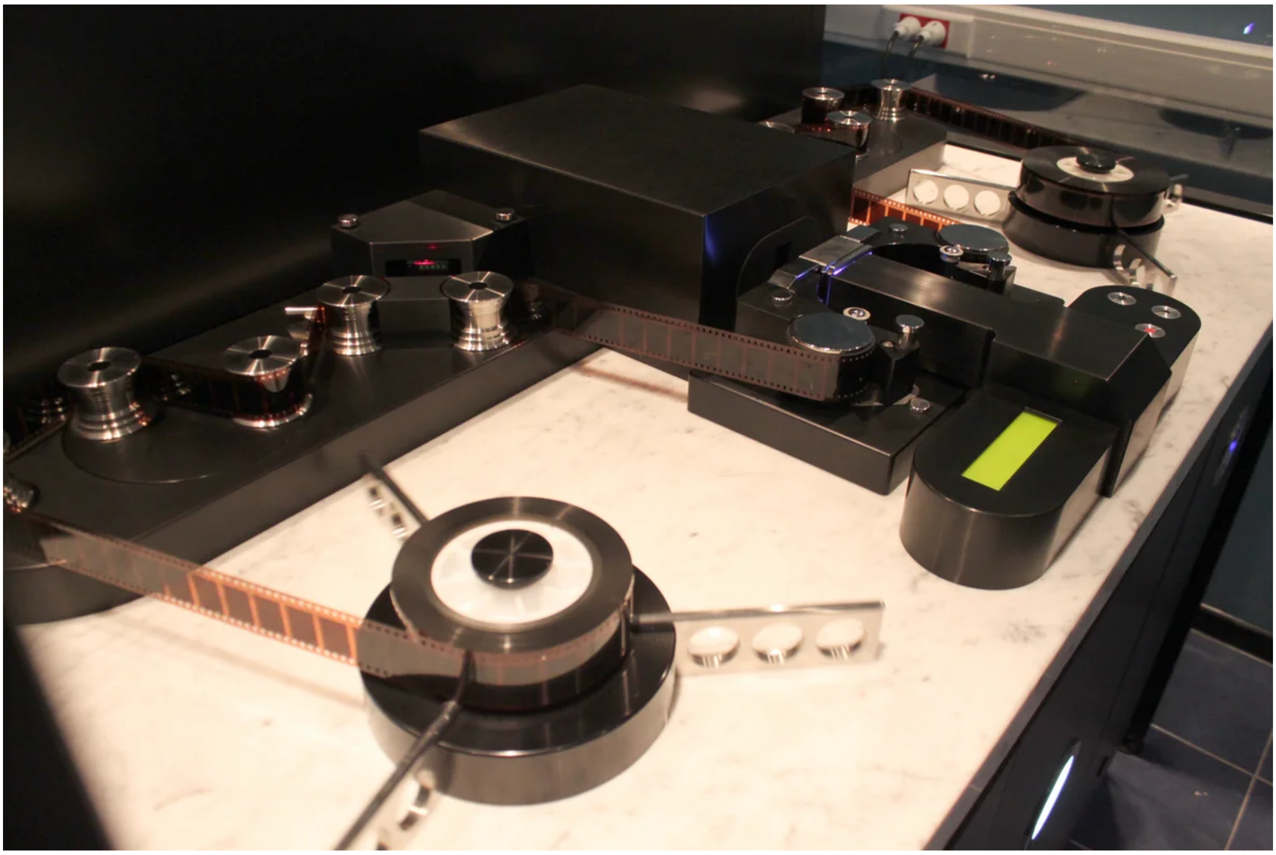
Now let's try to understand what range of densities the scanner “shines through”. As a test object, we took a sensitogram made on a contrasting black-and-white positive film, and put down their density values, measured on a densitometer, next to the fields.



Sensitogram on positive film with a wide range of densities.

Here are the results of the "first scan" - the sensitogram was re-captured with a digital camera. Determine for yourself from the above photo what maximum density our digital camera saw? The densitometer was able to "see" a density of 3.95. And what about the camera matrix?

We tested this sensitogram for cinema scanner, which is available at the Institute of Cinematography (VGIK) . A cabinet-sized scanner occupies an isolated section of a room. (In the previous sentence, there is a link to a short video of how the VGIK cinema scanner works.)

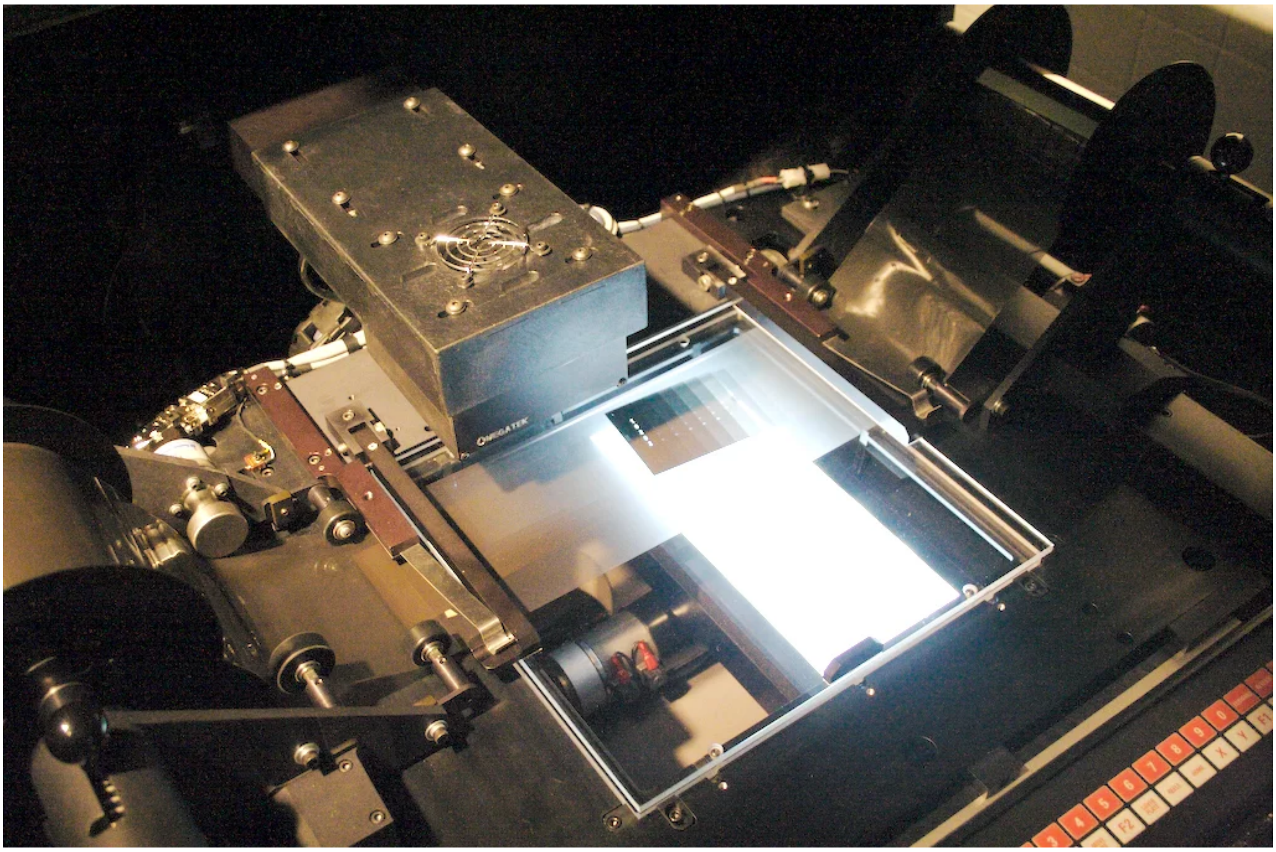


Cinema scanner at VGIK.

The maximum density that the scanner saw was D = 1.8.

Sensitogram after scanning (left), option on the right - chromaticity removed.

In the film archive of the Johnson Space Center, before scanning the originals of the lunar images, they first scan the gray scales, the same sensitograms.



The scale of gray fields on the scanner is made on a transparent film.

Scanning is performed with a Leica DSW700 scanner. The estimated cost of such a scanner is about $ 25,000.

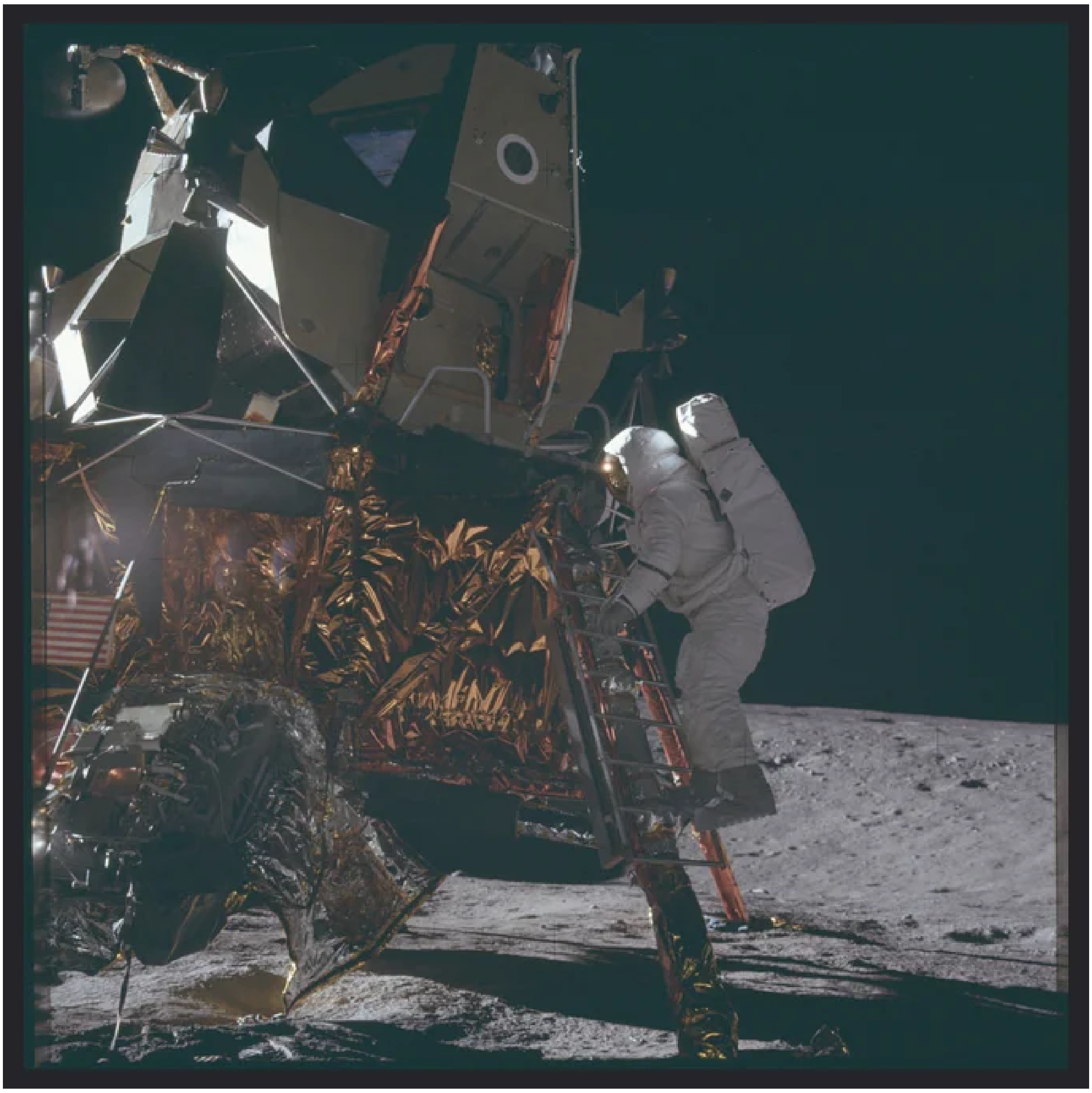
A scanner at the Johnson Space Center.

In order not to overload the article with information about different types of scanners (flatbed and drum), about different scanning modes (with and without increased lamp brightness), about cheap and expensive scanners (we have access to an ARRISCAN scanner, with an initial cost of about $ 400,000), we we will postpone these discussions for a separate article. For now, let's just voice the conclusion. **The maximum density "penetrated" by the scanner is limited to 2.4 B.** Therefore, when the maximum value of the printed density Dmax = 3.4 is mentioned in the passport data of the scanner, then this is an unconfirmed advertisement.

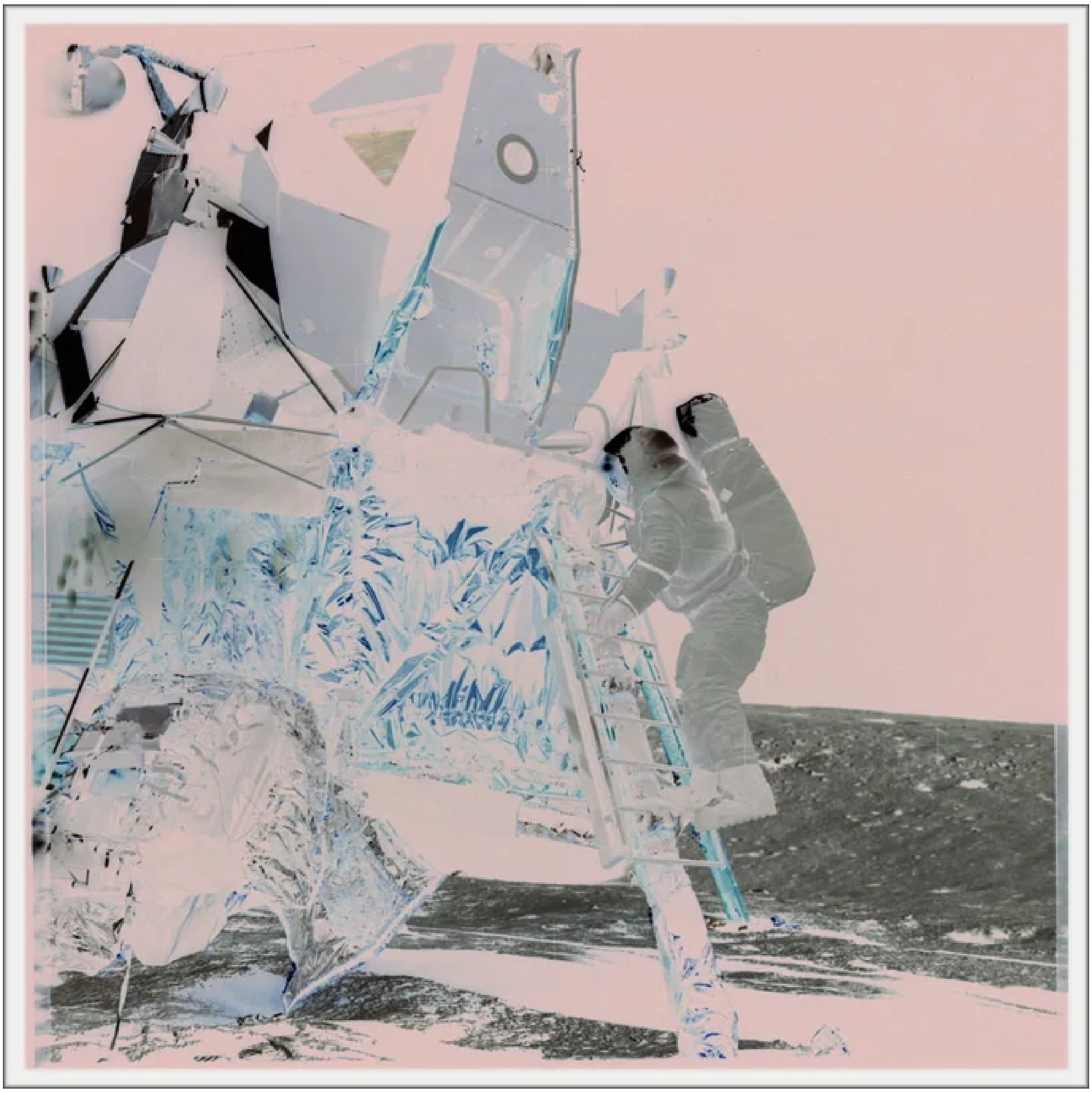
What follows from our densitometric measurements? And an unambiguous conclusion follows. The density of " **black** " on Kodak slides is so high that no scanner can "pierce" it (there is "bulletproof" blackness). So maybe the black space on the lunar images turned out to be green, and not black due to the fact that NASA scanned not a slide, but a completely different one - a low-contrast film with low maximum densities? Such a film can only be NEGATIVE. Only in this case it becomes clear why raw scanned images look low-contrast and do not have maximum density in the shadows.

Let's check how plausible the version is that NASA, under the guise of slides, actually scanned the negatives, and then, on a computer in a graphic editor, the scanned negatives were inverted into positive ones.

If we take a lunar frame not processed by "levels" and invert it (ie, turn it into a negative), then we will see that the dark green space will turn into a light pink filling of the entire frame.



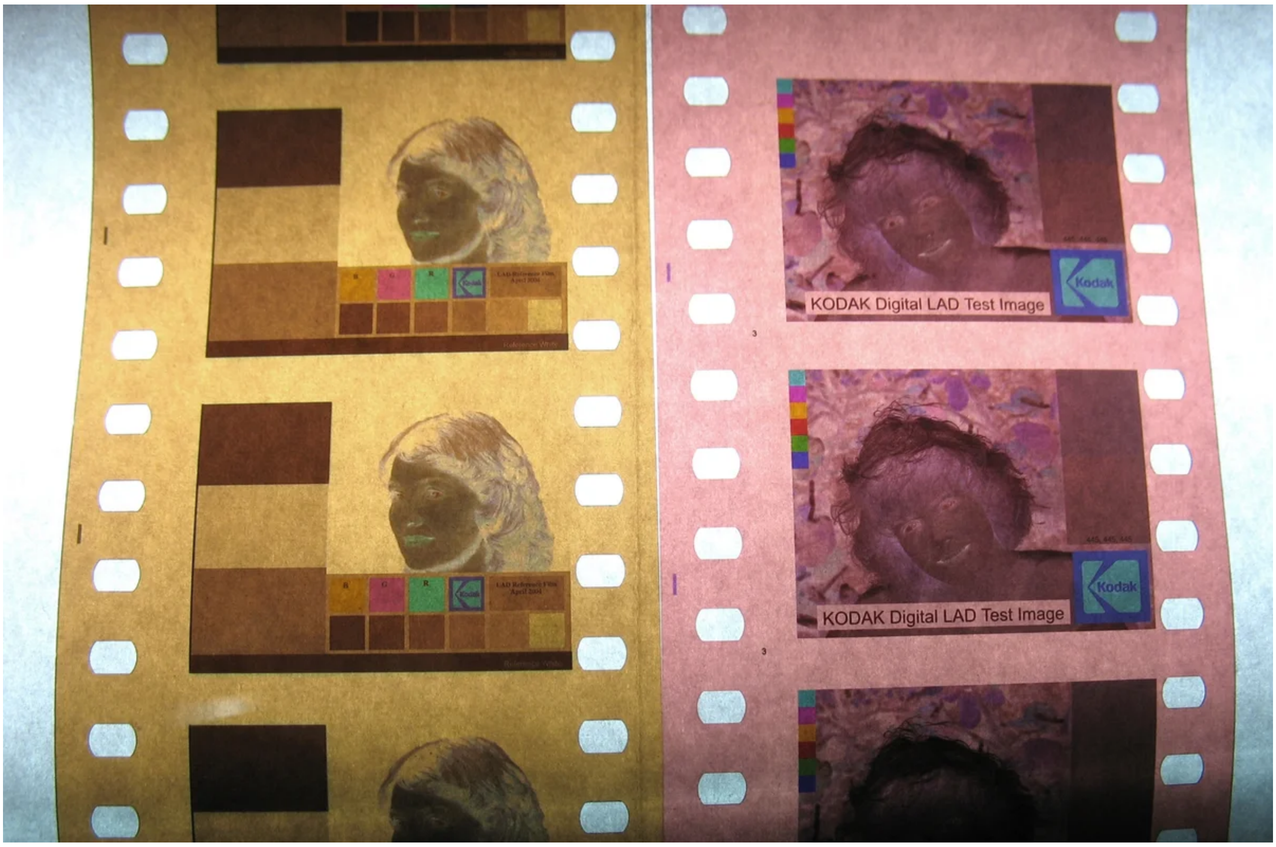
A still from the Apollo 12 mission.



Frame from Apollo 12 mission inverted (turned into negative).

Some people will probably think that this pink hue appeared by accident when setting up the scan, and it was not in reality, and we know for sure that this pink color was present in the image initially. And we can state this unequivocally, since this "pink tone" is nothing more than a colored color-forming component, which for simplicity is called a **mask** .

Everyone knows that color negative film has a bright yellow or orange color, but not everyone knows that this color belongs to a special mask located in the two lower layers, which is why color negative film is called masked. The color of the mask is not necessarily yellow-orange, it can be pink-red. The yellow-orange mask is used in negative films, and to obtain duplicate negatives (countertypes), films with a pink-red mask are made.



Color masked films: negative (left) and countertype (right).

Negative films have a high sensitivity - from 50 to 800 ISO units and are intended for shooting on location or in a pavilion. But no one uses countertype films for filming, they have a very low sensitivity, 100-200 times less than the sensitivity of negative films (about 1.5 ISO units), and they work with them in laboratories, on copiers. These tapes are used to make duplicates.

Masking is not used in films intended for direct viewing (positive and slide films), but is used only in those materials that are involved in the intermediate stages of obtaining the final image (negative and counter-type films). This is what countertype tapes are called - "intermediate", or in English Intermedia (inter - intermediate, media - means).

This is what a box of Kodak Intermediate film looks like.

If you thought that Intermedia films were some kind of exotic films of narrow application (as, for example, there are special photographic films for recording tracks of nuclear particles), then this is not so. Until recently, Intermedia films were released in **millions of kilometers** , and without these films, not a single film could be released.

And it is on such a film, on Intermediate, that the ORIGINALS of lunar images were made.

Output.

The fact that when scanning the originals of the "lunar" images, the black space turned green, indicates that, as an original, the Johnson Space Center stores materials that were not made on highly sensitive reversible photographic film (according to NASA legend, Ektahrom photographic film was used in extravehicular activities with photosensitivity 160 ASA); instead of these films, the "originals" were made on **masked** low-sensitivity (S = 1.5 ISO) and low-contrast Intermediate film.

Perhaps you have a natural question, for what purpose did NASA use Intermedia? The answer will be the following article: **"Why did you need an Intermediate to make the originals of the lunar images?"**

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Previous article about scanning ORIGINALS of lunar images:

The originals of the lunar photographs have been re-scanned. Photoshop again?

The next article will be about why the originals of the lunar images were taken on Intermediate.

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Cameraman L. Konovalov was with you. Until next time!